1243221

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

October 28, 2004

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: ***60/510,937***
FILING DATE: ***October 14, 2003***
RELATED PCT APPLICATION NUMBER: ***PCT/US04/32073***

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
for Intellectual Property
and Acting Director of the U.S.
Patent and Trademark Office

PROVISIONAL PATENT APPLICATION UNDER §111(b)	*Attorney Docket No.*	018778-9198
	First Named Inventor	
	Timothy Raabe	
	Express Mail Label No.	EV323582687US

Mail Stop PROVISIONAL PATENT APPLICATION
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Enclosed for filing is a complete provisional patent application entitled "SYSTEM AND METHOD FOR ELECTRIC FIELD SENSING OF OCCUPANCY STATE OF A WHEELCHAIR LIFT OR MOBILITY ACCESS DEVICE" invented by:

Timothy Raabe
628 South Riverside Drive
Winamac, Indiana 46996

Keith Heigl
6518 West 300 South
Winamac, Indiana 46996

David Heigl
532 Davis
Logansport, Indiana 46947

Bryan Hunt
265 West 950 South
Star City, Indiana 46985

and including the following documents:

Specification including Claims - 9 pages
Abstract of the Disclosure
Drawings - 26 sheets
Return Receipt Postcard
Check for $160.00 for filing fee
Also enclosed are:
Assignment
Cover letter for assignment
Check for $40.00 for assignment recording fee

Charge or credit Deposit Account No. 50-1965 with any shortage or overpayment of the fees associated with this communication. A duplicate copy of this sheet is enclosed.

☒ Customer Number

1131

Respectfully submitted,

Date: October 14, 2003

Martin L. Stern, Reg. No. 28,911
Michael Best & Friedrich LLC
401 North Michigan Avenue, Suite 1900
Chicago, Illinois 60611

cc: Docketing
Wkg Atty. DRM
Resp Atty. MLS
S:\CLIENT\018778\9198\C0272989.1

PROVISIONAL PATENT APPLICATION FOR SYSTEM AND METHOD FOR ELECTRIC FIELD SENSING OF OCCUPANCY STATE OF A WHEELCHAIR LIFT OR MOBILITY ACCESS DEVICE

FIELD OF THE INVENTION

[0001] The invention relates to object or obstruction recognition in safety systems for wheelchair lifts, ramps and similar mobility access devices (hereinafter collectively referred to as "wheelchair lift" or "lifts"). More specifically, the present invention relates to an electric field system and method for sensing the presence of an object on a wheelchair lift.

BACKGROUND OF THE INVENTION

[0002] Safety systems for vehicle wheelchair lifts are well known, and have been employed to ensure the well being of wheelchair lift users for many years. Numerous safety systems for wheelchair lifts have been proposed that include mechanical, electrical, or electromechanical sensing. Existing sensing methods are disadvantaged because they require trade-offs between sensitivity range and accurate calibration. Thus, the range of operation often comes at the expense of the sensitivity of discrimination in the method. It would be advantageous to provide a method and system for self-calibration of a sensor on a wheelchair lift during known unoccupied instances. By employing a self-calibrating sensor system, a flexible approach may be achieved where it is unimportant how large or heavy an obstruction must be before it may be sensed. A sensing system that overcomes such prior art trade-offs has been elusive to those knowledgeable in the art.

[0003] For a sensor to be able to recognize an object or obstruction on a vehicle wheelchair lift, the sensor must be sensitive to discriminate between the presence of a real obstruction (e.g., a user), and a perceived (e.g., sensor noise or latency) or unimportant obstruction (e.g., a piece of trash or debris). To discriminate between the two types of obstructions, sensors (or systems interpreting sensor data), have set thresholds which necessarily exclude specific sensing ranges. For example, U.S. Patent No. 5,261,779 to Goodrich for "Dual Hydraulic Parallelogram Arm Wheelchair Lift", issued Nov. 16, 1993 to applicants' assignee discloses a load sensing disable switch so that the platform cannot fold closed (stowed) if there is more than a given weight (say 30-80 lbs.) on the platform.

[0004] Other alternative electromechanical sensing systems may include the use of trip switches, pressure sensing devices and the like to detect a platform load by detecting hydraulic fluid pressure in excess of a predetermined hydraulic pressure threshold. The physical sensing switches must be routinely maintained and calibrated to ensure proper operation. Also, switches are prone to wear and failure over time, and may be difficult and expensive to replace.

[0005] Moreover, as wheelchair lifts and platforms are integrated with modern vehicles with electronic access controls, it is desirable to implement an electronic-based sensing system that can seamlessly operate with the existing access system. One such proposed vehicle controller as disclosed in U.S. Patent Application Serial Number 10/142,712 entitled "Electronic Controller for Vehicular Wheelchair Access" filed May 10, 2002 by applicants' assignee is incorporated herein by reference in its entirety. The electronic controller communicates with the OEM vehicle controller to coordinate vehicle door opening, deployment of a wheelchair ramp or platform, and kneeling of the vehicle. The electronic controller employs current sensors and timers in connection with detailed controller algorithms to detect the presence of obstructions or loads. Over time, due to mechanical wear, the programmed current and time thresholds will need to be reset. Therefore, it is desirable to improve the disclosed controller by implementing a robust and self-calibrating sensing system that uses readily available inexpensive components.

SUMMARY OF THE INVENTION

[0006] An embodiment of the invention provides an electric field proximity sensing system for detecting the presence of an object on a wheelchair lift and disabling the lift from operating. One or more electrodes are installed on a wheelchair lift or ramp. The electrodes are electrically excited by an electric field imaging device in communication with an electronic controller or microprocessor. The electric field imaging device drives the connected electrodes with a low frequency sine wave thereby creating an electric field. The electric field imaging device, operating as a transceiver, receives inputs from the electrodes, and is able to discriminate changes in the electric field. By connecting the electric field imaging device to a controller, several electrodes may be selected sequentially to detect an object in various locations, or depending on electrode placement, electrodes may be selected to determine an object's size, shape, and distance from the electrodes. When an object is

sensed by the electric field imaging device, the controller can disable a vehicle function such as stowage of a wheelchair lift, so that user injuries are prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention is described with reference to the accompanying figures which illustrate embodiments of the present invention. However, it should be noted that the invention as disclosed in the accompanying figures and appendices is illustrated by way of example only.

[0008] FIG. 1 is an isometric view of an exemplary parallelogram-type wheelchair lift showing the general arrangement of components.

[0009] FIG. 2 is a block diagram illustrating a vehicle control system with electric field sensors.

[0010] FIG. 3 is a block diagram illustrating a method of object sensing for a vehicle equipped with a wheelchair lift.

[0011] FIG. 4 is an illustration of an exemplary electric field sensor for use with the vehicle control system of FIG. 2.

[0012] Appendix A is a technical specification for a preferred electric field imaging device.

[0013] Appendix B is a printout of exemplary controller code for electric field sensing of an object on a wheelchair lift.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0014] Referring now to FIGS. 1-3, and especially to FIG. 2, a vehicle control system 400 including electric field (hereinafter "EF") proximity sensing is shown. The system includes an EF imaging device 416 which is integrated into and in communication with the vehicle controller 408. The communication between EF imaging device 416 and controller 408 may follow various protocols including, but not limited to constant communication, and query/response-type communication wherein the EF imaging device 416 does not send any data to controller 408 unless it is asked to. Vehicle controller 408 is responsible for overall

control, coordination and synchronization of OEM vehicle functions such as door motor 420, key control 412, and interior controls 304 with after-market installed wheelchair platform lift 418 to facilitate vehicle handicapped accessibility. Vehicle controller 408 communicates with the OEM standard controller 406 via communications bus 405. Since wheelchair platform lift 418 is an after-market system, it typically cannot communicate with OEM controller 406. The controller 408 monitors signals from the OEM controller 406 via communications bus 405 and relays them to the various aforementioned OEM vehicle functions to synchronize access operations.

[0015] For example, a mobility-challenged user in a wheelchair outside a vehicle equipped with a wheelchair platform lift such as a van or minivan may press a button on a keyless-entry remote or key-fob 200 to access the vehicle. The keyless-entry remote 200 typically transmits a radio frequency (RF) signal which is received at antenna 402 and processed by receiver 404. The receiver 404 relays the access request to the controller 408 which then requests that OEM controller 406 unlock doors via key control 412, and open sliding doors 420. After coordinating these operations, controller 408 may then order deployment of the wheelchair lift platform 418. The user accesses the lift platform (an exemplary platform is shown as 1 in FIG. 1), and is lifted from ground level to the vehicle door threshold height.

[0016] To prevent injury to the wheelchair lift user, EF electrodes 422 are arranged on the wheelchair lift 1. An exemplary arrangement of EF electrodes is illustrated in FIG. 4. As shown, the electrode arrangement is designed as a set of four electrodes which are substantially the same width of the lift platform. Each of the electrodes may comprise, for example, approximately 35 feet of 30 gauge wire in a zig-zag pattern within an area of 4.5" by 35". The EF electrodes 422 may be placed on areas of the lift 1 for which presence detecting is desired (e.g., the inboard and outboard barriers, and the threshold). It is particularly important to detect the presence of an object on the lift platform 10, threshold 20, and roll stop 30 although it is obvious to one knowledgeable in the art that object detection may be desired in other locations as well including the edge of the door and inside the vehicle. EF electrodes 422 may be wire such as 30 gauge, metallic film material such as mylar, or flex circuits. The EF electrodes 422 are permanently attached to the lift using adhesive or other attachment means such as clips or ty-wraps.

[0017] A preferred EF imaging device 416 is the Motorola 33794, for which the technical specifications can be found in Appendix A and are incorporated herein by reference. The EF electrodes 422 in communication with EF imaging device 416 emit an electric field with a known electrical characteristic. The EF imaging device 416 is able to selectively energize one of several connected electrodes 422 in response to controller 408. The EF imaging device 416 includes a receiver multiplexer which simultaneously allows for sampling of the electric field being emitted by the selected electrode 422. If an object is within an emitted electric field of an electrode 422, the EF imaging device 416 discriminates the object's presence due to a change in effective capacitance as the object gets closer to the electrode 422 and modifies the electric field between the electrode 422 and surrounding electrically common objects. The object presence can be observed by the capacitance change on each electrode 422. Aside from an object's presence, the EF imaging device 416 may also detect the size and shape of an object as well as its distance from one or more electrodes. The shape and size of an object can be determined by using multiple electrodes over an area and observing the capacitance change on each of the electrodes. The absence of change in electrode capacitance would be indicative of electrodes that have nothing near them, while those that do show a capacitive change have a part of the object near them. Similarly, a large change in an electrode's electric field may correspond to a large object, while a small change in the electric field may correspond to a small object.

[0018] In FIG. 3, a flow chart of a method for EF sensing of an object on a wheelchair lift is shown. Starting at block 100, a user inside a wheelchair lift-equipped vehicle triggers lift deployment by pressing a button or activating a switch inside the vehicle. Depending on the lift configuration, it may be folded or stowed inside or underneath the vehicle. By triggering lift deployment, the lift is unstowed and brought to the egress level of the vehicle. The user-initiated request to deploy the lift is received at the controller 408 in block 110, and the controller 408 coordinates opening of a door and subsequent deployment of the lift. The controller 408 recognizes when the lift is fully deployed by using time thresholds, sensed lift motor current measurements, or other sensing means and instantly energizes one or more EF electrodes. By energizing the EF electrodes at the instant that the lift is fully deployed, the controller 408 in communication with the EF imaging device 416 may calibrate the EF electrodes as shown in block 120. The electric fields generated at the

instant the lift is fully deployed serve as baseline electric fields since there can be no objects on the lift at that very instant.

[0019] In block 130 the user accesses the lift and requests lift lowering. The lift lowering request is received at the controller 408 which queues the lowering request and activates the appropriate EF electrodes via the EF imaging device 416 in block 140 to determine if the user is located on the lift so that the lift can be lowered safely. For example, appropriate EF electrodes to energize when a lift lowering is requested could be located on the lift threshold 20 shown in Fig.1. In this way, if a user accidentally requests lift lowering before being safely situated on the platform 10, the EF imaging device 416 will energize the threshold electrode and sample the electric field. The EF imaging device 416 selectively energizes the electrodes and compares the sampled electric fields to the baseline electric fields and may detect a change in one or more EF electrode fields. The EF imaging device 416 communicates the EF electrode's field change to the controller 408 which prevents lowering of the lift in block 150. The controller 408 in block 150 may also discard the queued lowering request and indicates to the user that it is unsafe to lower the lift by sounding an alarm or activating another indicating means. The user may then adjust their position on the lift or move an obstruction and again request lift lowering at block 130. Alternatively, in block 140, if the EF imaging device 416 energizes the threshold electrode and determines that the sampled electric fields do not differ from the baseline electric fields, the controller 408 is so notified by the EF imaging device 416. The controller 408 in block 160 sends a signal to the lift motor, the lift is lowered to ground level, and the user exits the lift.

[0020] In block 170 the wheelchair lift is deployed and waiting to be raised. A user enters the lift and initiates a lift raise request in order to access the vehicle. The user-initiated lift raise request is accomplished by actuating a button, switch, or the like on the wheelchair lift. Alternatively, a lift operator such as the vehicle driver may actuate a button, switch, or the like inside or outside the vehicle. The controller 408 having received the lift raise request, queues the raise request and activates the appropriate EF electrodes via the EF imaging device 416 in block 180 to determine if the user is located on the lift so that the lift can be raised safely. The EF imaging device 416 selectively energizes the electrodes and compares the sampled electric fields to the baseline electric fields and may detect a change in one or more EF electrode fields.

[0021] For example, an appropriate EF electrode to energize when a lift raising is requested could be located on the lift rollstop 30 shown in Fig.1. In this way, if a user accidentally requests lift raising before being safely situated on the platform 10, the EF imaging device 416 will energize the rollstop electrode and sample the electric field. If an object is detected on the rollstop 30, the EF imaging device 416 communicates the EF electrode's field change to the controller 408 which prevents raising of the lift in block 190. Similarly, it may be desirable to determine if an object is present in the threshold 20 area so the platform 10 may be raised completely without injuring a person inside the vehicle near the threshold 20 or damaging the lift 1. Therefore, after verifying that the user is safely situated on the platform 10, the controller 408 may communicate with the EF imaging device 416 to energize the threshold electrode and sample the electric field. If an object is detected on the threshold 20, the EF imaging device 416 communicates the EF electrode's field change to the controller 408 which prevents raising of the lift in block 190. The controller 408 in block 190 may also discard the queued raise request and indicate to the user that it is unsafe to raise the lift by sounding an alarm or activating another indicating means. The user may then adjust their position on the lift or move an obstruction on the platform 10 or threshold 20 and again request lift raising at block 170. Alternatively, in block 180, if the EF imaging device 416 energizes the roll stop electrode and threshold electrode and determines that the sampled electric fields do not differ from the baseline electric fields, the controller 408 is so notified by the EF imaging device 416. The controller 408 in block 200 sends a signal to the lift motor, the lift is raised to vehicle threshold level, and the user enters the vehicle.

[0022] Having entered the vehicle, the user requests stowing of the wheelchair lift by pressing a button or activating a switch inside the vehicle. By triggering lift stowage, the lift is folded and stored inside or under the vehicle. The user initiated request to stow the lift is received at the controller 408 which queues the stow request and activates the appropriate EF electrodes via the EF imaging device 416 in block 210 to determine if the user or another object is located on the lift 1 so that the lift can be stowed safely. Similar to the lowering and raising operations described above, the EF imaging device 416 selectively energizes the electrodes and compares the sampled electric fields to the baseline electric fields and may detect a change in one or more EF electrode fields. The EF imaging device 416 communicates the EF electrode's field change to the controller 408 which prevents stowing of the lift in block 230.

[0023] Prior to a stowing operation it is desirable to ensure that no part of the lift is occupied or obstructed. As such, the controller 408 may communicate with the EF imaging device 416 to energize all lift electrodes. For example, the controller 408 communicates with the EF imaging device 416 to sequentially energize electrodes on the rollstop 30, platform 10, and threshold 20. The EF imaging device 416 compares the sampled electric fields to the baseline electric fields for each electrode, and if a change is detected in any field, the field change is communicated to the controller 408 which prevents stowing of the lift. The controller 408 in block 230 may also discard the queued stow request and indicate to the user that it is unsafe to stow the lift by sounding an alarm or activating another indicating means. The user may then clear the obstruction and again request lift stowage. Alternatively, in block 210, if the EF imaging device 416 energizes the electrodes and determines that the sampled electric fields do not differ from the baseline electric fields, the controller 408 is so notified by the EF imaging device 416. The controller 408 in block 220 sends a signal to the stow/fold motor, the lift is stowed, and the vehicle door is closed.

[0024] The method for EF sensing of an object on a wheelchair lift shown in FIG. 3 and described above is implemented using a controller programmed with an EF proximity detection algorithm, a sample of which is shown in Appendix B and incorporated herein by reference in its entirety.

WHAT IS CLAIMED IS:

1. A vehicle wheelchair lift obstruction detection system comprising:

a control module linked to communicate with a vehicle's OEM control system, the control module intercepting and relaying control signals from the OEM control system to OEM and aftermarket systems;

at least one electrode defining an obstruction detection area on the vehicle wheelchair lift, wherein the obstruction detection area comprises an electric field with known electrical characteristics, the electrode sampling the electric field electrical characteristics whereby the characteristics are altered in response to a proximate object on the wheelchair lift; and

an electric field imaging device in communication with the control module for selecting an electrode and for determining the presence of an obstruction in an obstruction detection area, the detected obstruction reported to the control module in response to a comparison by the electric field imaging device of the emitted electric field and the sampled electric field.

ABSTRACT

Disclosed are systems and methods for object or obstruction recognition using electric field sensing for the presence of objects on a wheelchair lift and disabling the lift from operating. One or more electrically excited electrodes are installed on a wheelchair lift or ramp to produce electric fields. An electric field imaging device, operating as a transceiver, receives inputs from the electrodes, and is able to discriminate changes in the electric field. By connecting the electric field imaging device to a controller, several electrodes may be selected sequentially to detect an object in various locations, or to determine an object's size and shape. When the electric field imaging device senses an object, the controller, in communication with the electric field imaging device, can disable a vehicle function such as stowage of a wheelchair lift, so that user injuries are prevented.

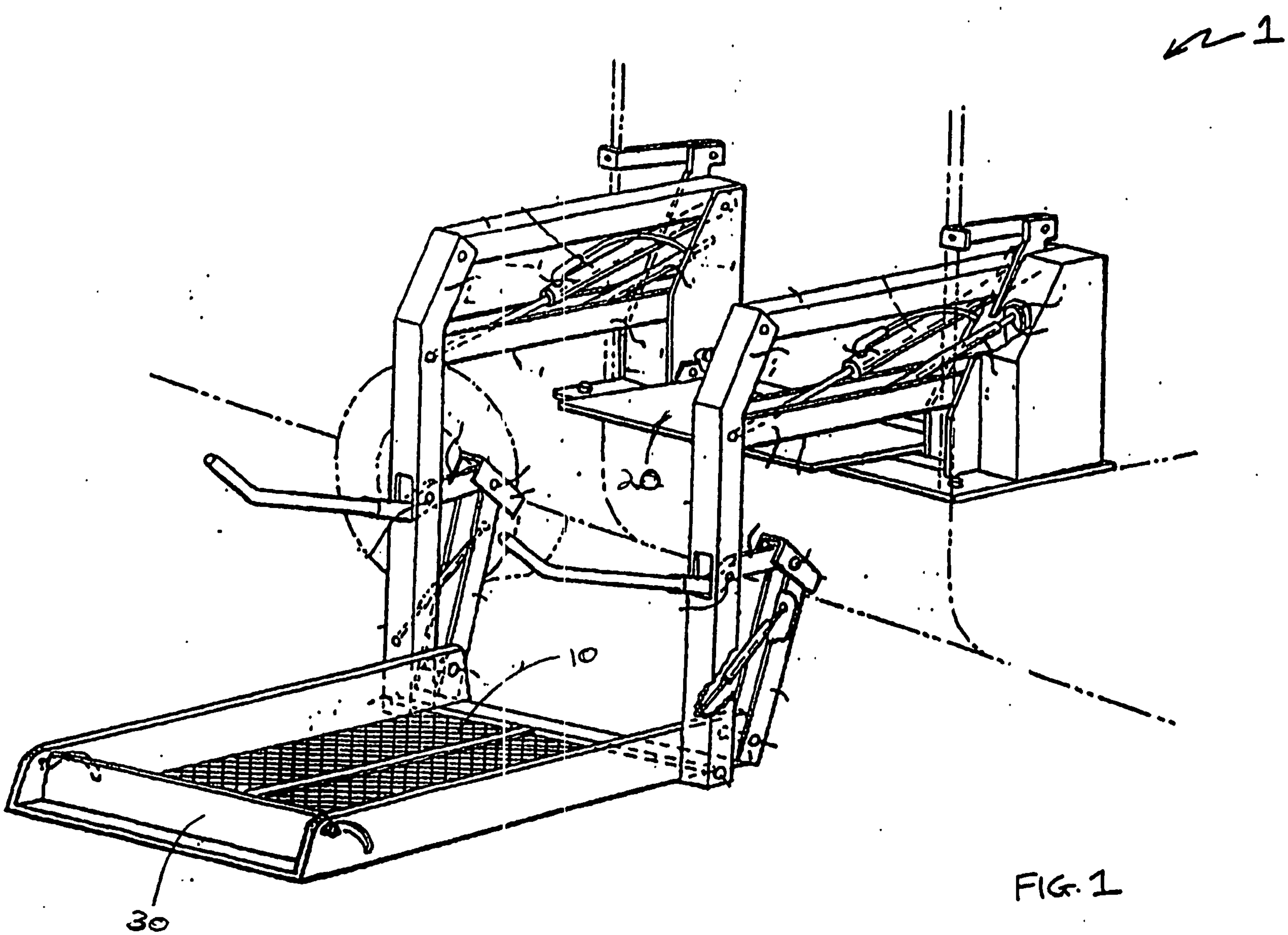
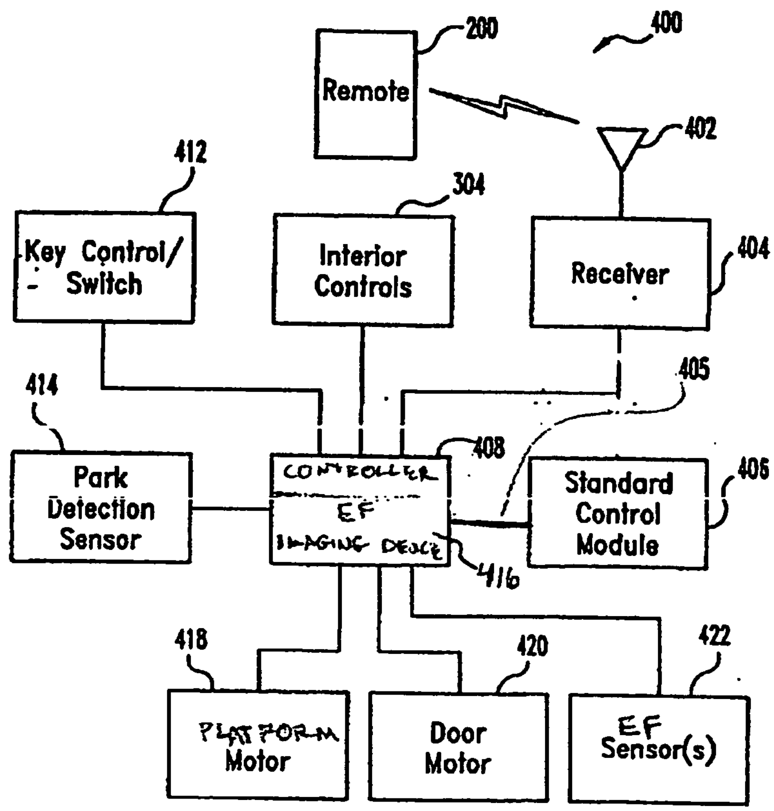


FIG. 1



200
400
Remote
402
412
304
Key Control/ Switch
Interior Controls
Receiver
404
405
414
408
Park Detection Sensor
CONTROLLER
EF
IMAGING DEVICE
Standard Control Module
406
416
418
420
422
PLATFORM Motor
Door Motor
EF Sensor(s)

Fig. 2

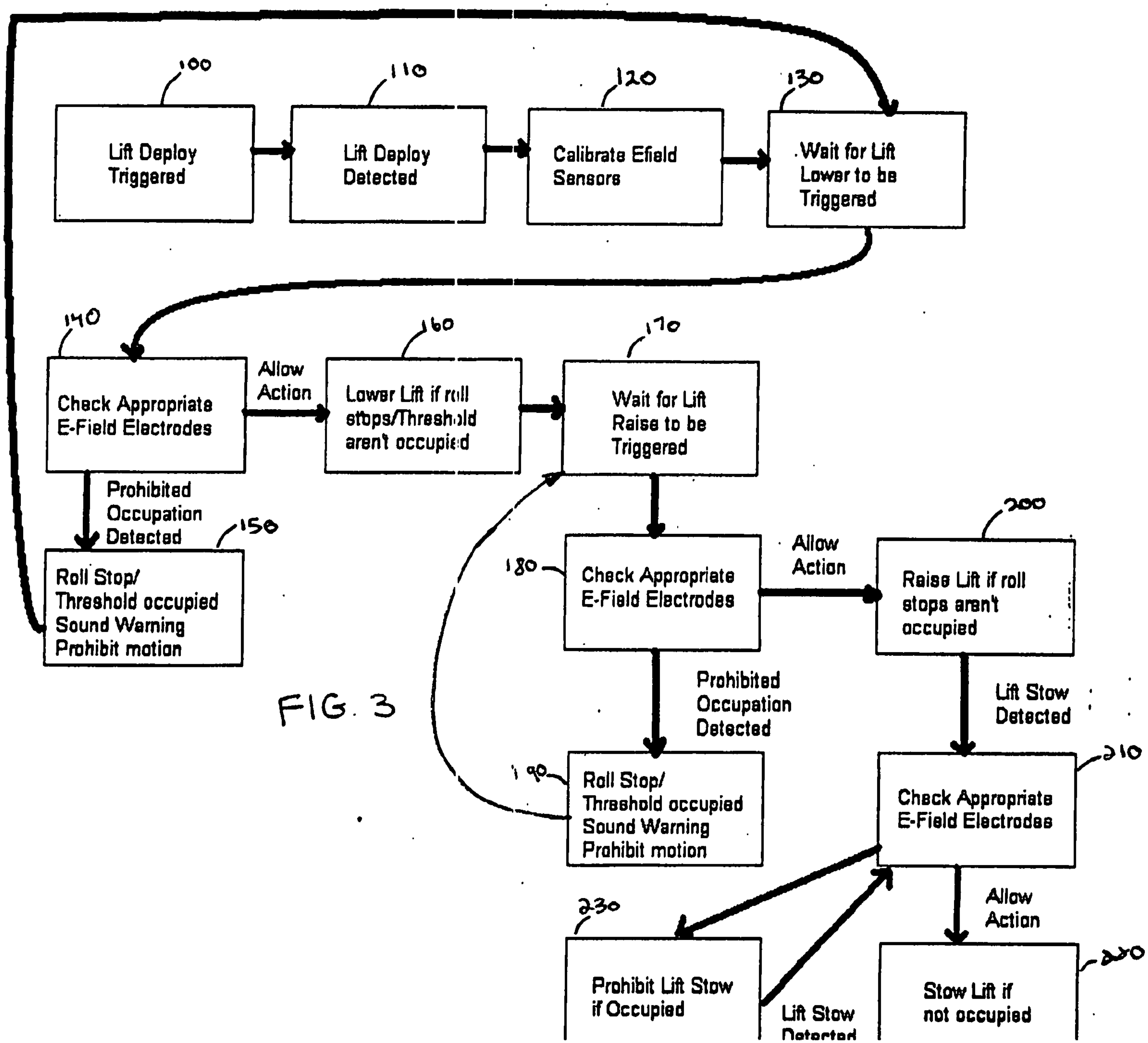
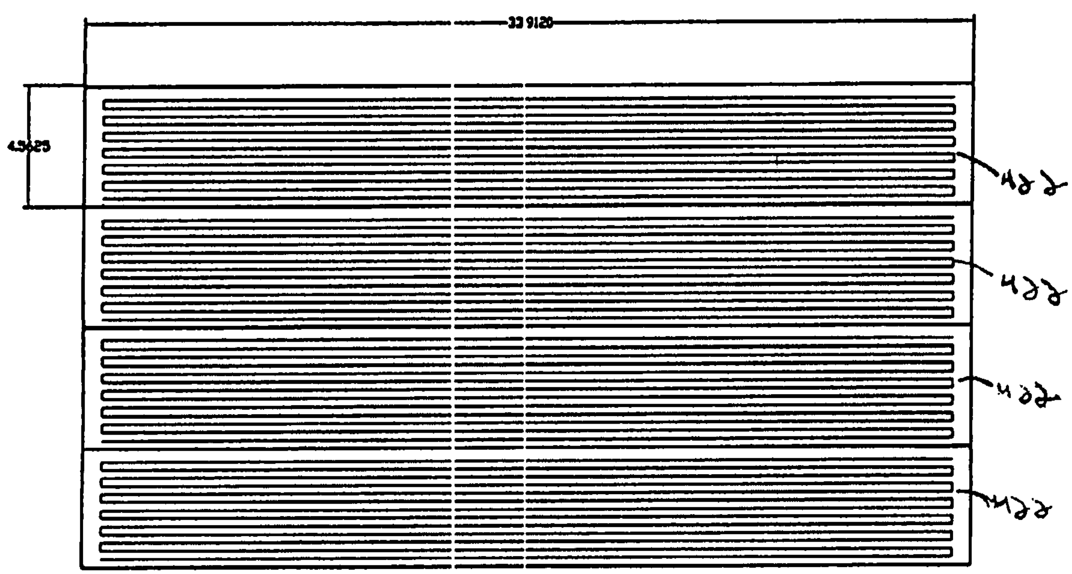

100
Lift Deploy Triggered
110
Lift Deploy Detected
120
Calibrate Efield Sensors
130
Wait for Lift Lower to be Triggered
140
Check Appropriate E-Field Electrodes
Allow Action
160
Lower Lift if roll stops/Threshold aren't occupied
170
Wait for Lift Raise to be Triggered
Prohibited Occupation Detected
150
Roll Stop/ Threshold occupied Sound Warning Prohibit motion
180
Check Appropriate E-Field Electrodes
Allow Action
200
Raise Lift if roll stops aren't occupied
Prohibited Occupation Detected
Lift Stow Detected
190
Roll Stop/ Threshold occupied Sound Warning Prohibit motion
210
Check Appropriate E-Field Electrodes
Allow Action
230
Prohibit Lift Stow if Occupied
Lift Stow
220
Stow Lift if not occupied

FIG. 3

FIG. 4



Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US04/032073

International filing date: 30 September 2004 (30.09.2004)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/510,937
Filing date: 14 October 2003 (14.10.2003)

Date of receipt at the International Bureau: 05 November 2004 (05.11.2004)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse